OGC Web Coverage Service (WCS) Specification

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Definition of Some Terms

- Operation
  - Specification of a transformation or query that an object my be called to execute
- Interface
  - Named set of operations that characterize the behaviour of an entity
- Service
  - A distinct part of the functionality provided by an entity through interfaces
- Service instance
  - An actual implementation of a service; synonymous with server
- Client
  - A software component that can invoke an operation from a server
- Request
  - An invocation by a client of an operation
- Response
  - The result of an operation returned from a server to a client
- Capabilities XML
  - Service-level metadata describing the operations and content available at a server

Introduction

- WCS specification defines the way to access real coverage data (raster data).
- WCS 1.0 is the base standard for the coverage service in OGC.
  - This presentation concentrates on the introduction to WCS1.0 because it is the most widely implemented WCS specification.
- A new version of WCS, version 1.1.0 has been developed by OGC.
  - A summary of new functions defined in WCS 1.1.0 will be discussed.
- Currently, the revision working group of WCS is developing a new version of WCS. It will also be summarized in this presentation

Scope, conformance, normative references

- Scope: grid coverages with homogeneous range sets
  - Provide web-based standard interface to access real multi-dimensional grid coverages.
  - Not cover the access to other types of coverage data.
- Conformance: see Annex C
- Normative references: MIME, HTTP, URI, WMS, GML, XML, …

request

- HTTP request methods: GET and POST
- **Key-value pair encoding** (GET/POST). Names/keys are not case sensitive, but values are. The order is not important.
- http://myserver/myservice?REQUEST=DescribeCoverage&SERVICE=WCS&version=1.0.0&coverage=`Landsat_TM_Mosaic`
- Or use HTML form

```
<form method=post/get action="myservice">
  <input name=request value="DescribeCoverage">
  <input name=service value="WCS">
  <input name=version value="1.0.0">
  <input name=coverage value="Landsat_TM_Mosaic">
  <input type="submit" value="describe this   coverage">
</form>
```

Request (cont'd)

- XML encoding

```
<DescribeCoverage service="WCS" version="1.0.0">
      <Coverage>Landsat_TM_Mosaic</Coverage>
</DescribeCoverage>
```

- To support SOAP messaging, enclose XML request in a SOAP envelope as follows:

```
<env:Envelope
 xmlns:env="http://www.w3.org/2001/09/soap-envelope">
   <env:Body>
     request document here
   </env:Body>
</env:Envelope>
```

Response

- XML encoding
- If valid request: corresponding exactly to the request as detailed in the appropriate specification. Most top-level element has attributes version (required) and updateSequence (optional).
- If invalid request: Service Exception

Response (cont'd)

Exception Schema:

```
<xs:schema targetNamespace="http://www.opengis.net/ogc" xmlns:ogc="http://www.opengis.net/ogc"
    xmlns:xs="http://www.w3.org/2001/XMLSchema" >
    <xs:element name="ServiceExceptionReport">
      <xs:complexType>
           <xs:sequence>
             <xs:element name="ServiceException" type="ogc:ServiceExceptionType"
                      minOccurs="0" maxOccurs="unbounded">
             </xs:element>
           </xs:sequence>
           <xs:attribute name="version" type="xs:string" fixed="1.2.0"/>
           </xs:complexType>
    </xs:element>

    <xs:complexType name="ServiceExceptionType">
       <xs:simpleContent>
           <xs:extension base="xs:string">
              <xs:attribute name="code" type="xs:string‟ />
              <xs:attribute name="locator" type="xs:string" use="optional‟ />
           </xs:extension>
       </xs:simpleContent>
    </xs:complexType>
</xs:schema>
```

GetCapabilities request

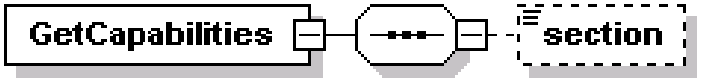
- Key-value pair encoding

Request Parameter	Required/ Optional	Description
REQUEST=GetCapabilities	Required	Request name
VERSION=1.0.0	Optional	Request version
SERVICE=WCS	Required	Service type
SECTION=/ *or* /WCS_Capabilities/Service *or* /WCS_Capabilities/Capability *or* ?WCS_Capabilities/ContentMetadata	Optional	Section of Capabilities document to be returned
UPDATESEQUENCE	Optional	Capabilities version

GetCapabilities request (cont'd)

- XML encoding

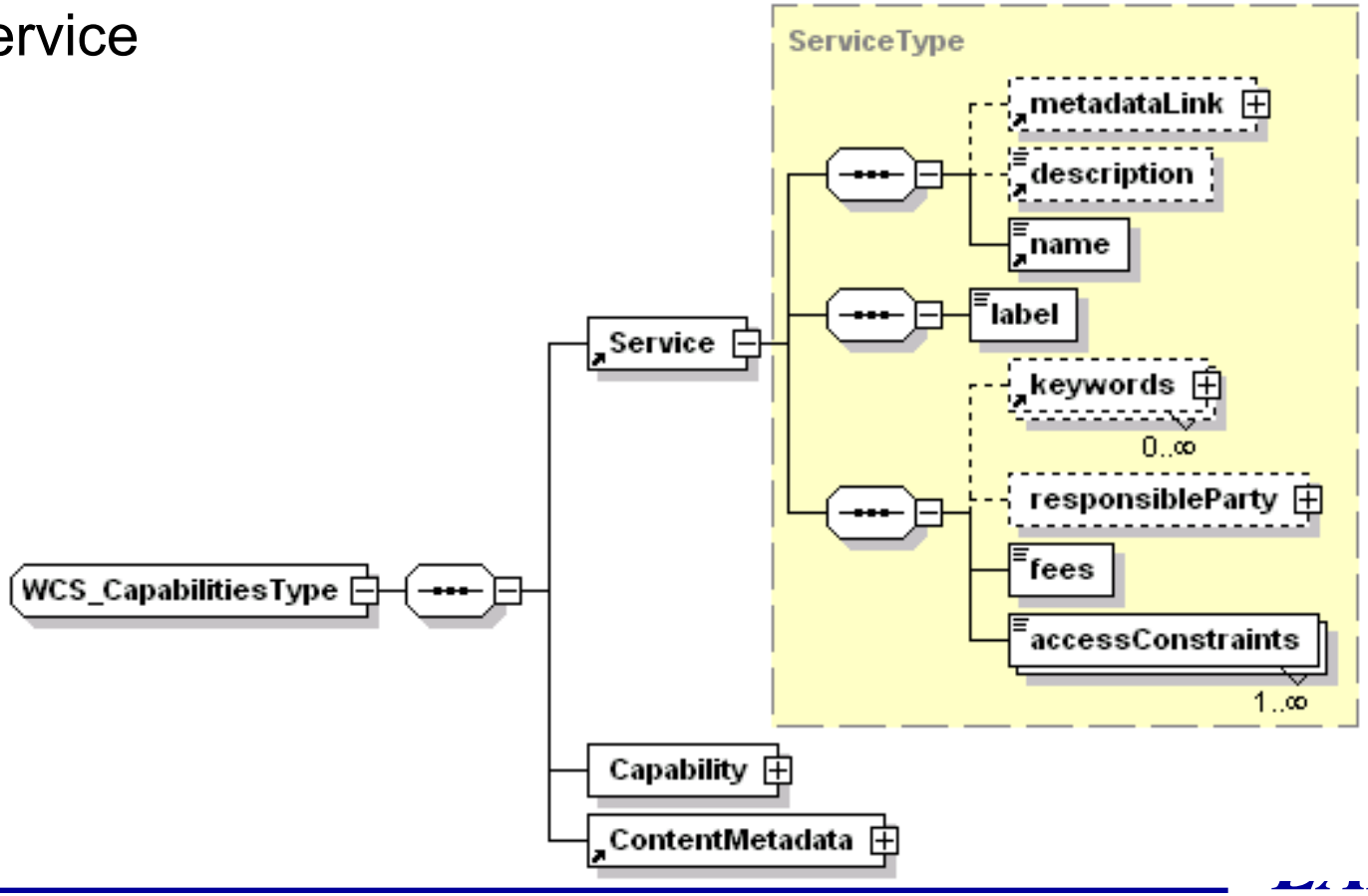
```
<GetCapabilities version="1.0.0" service="WCS">
   <section>/WCS_Capabilities/Capability</section>
</GetCapabilities>
```



Attribute	Required / Optional	Description
version	Optional	Request version. Defaults to the latest available version, currently 1.0.0.
service	Required	Service type (needed when several services share a single access point)
update-Sequence	Optional	Used for cache management. A service provider must increase this value when adding new content.

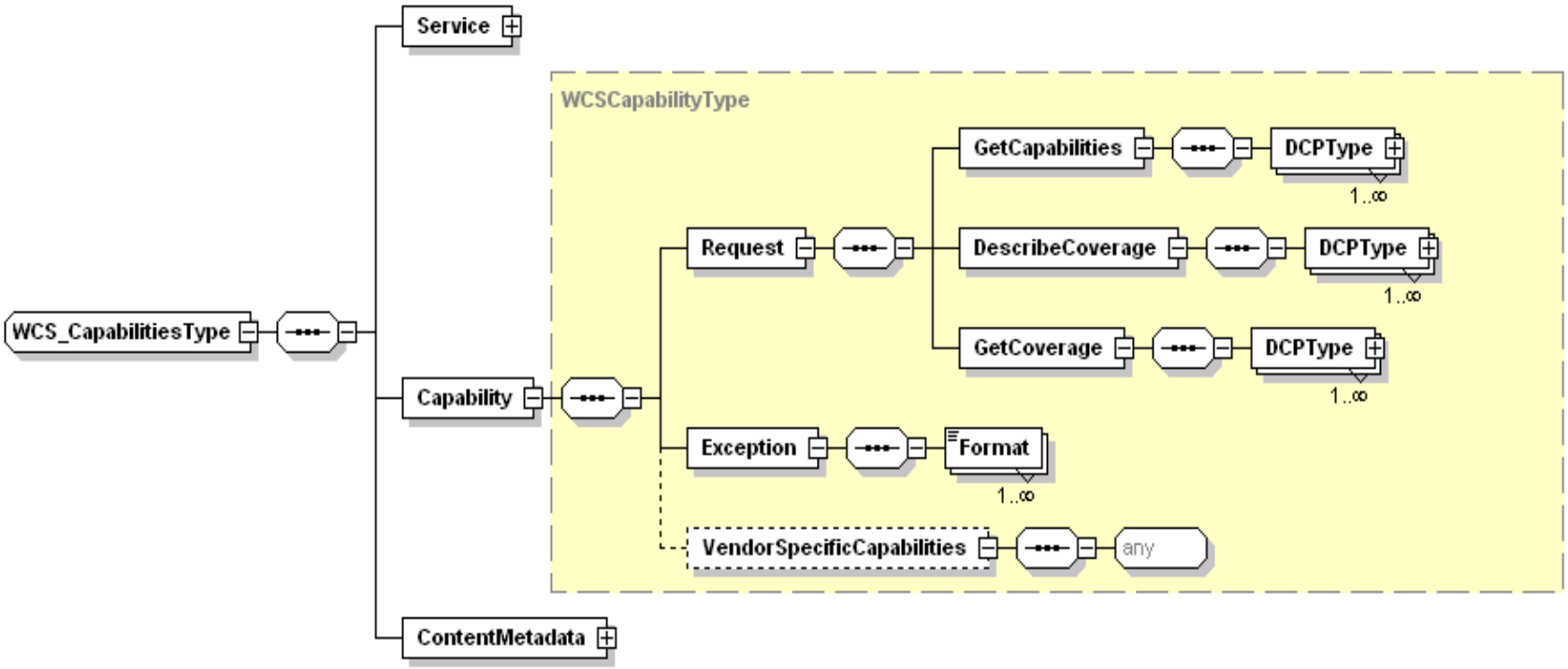
GetCapabilities response

- Top level element WCS_Capabilities has three sub elements: Service, Capability, and ContentMetadata.
- Service



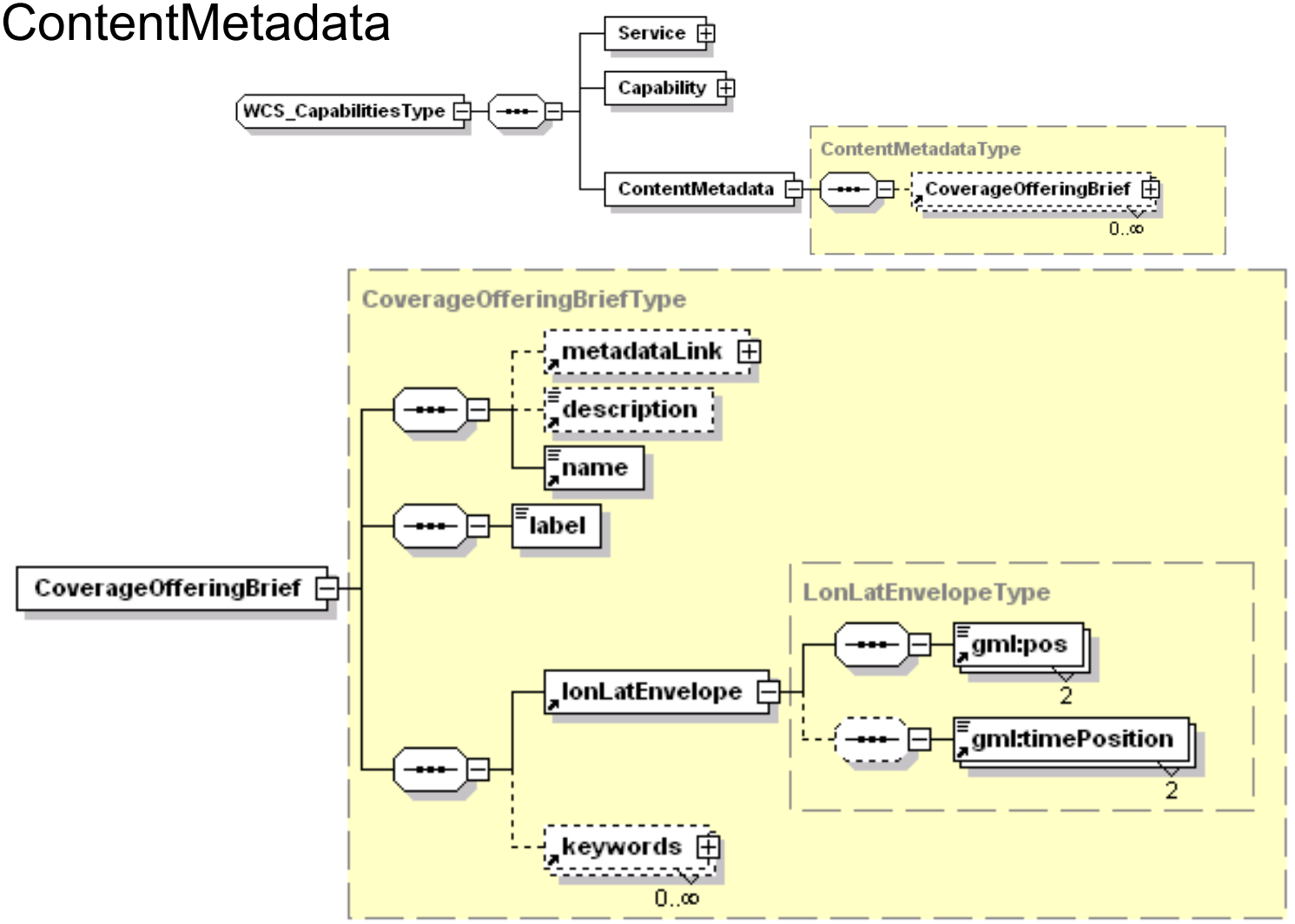
GetCapabilities response (cont'd)

- Capability



GetCapabilities response (cont'd)

- ContentMetadata



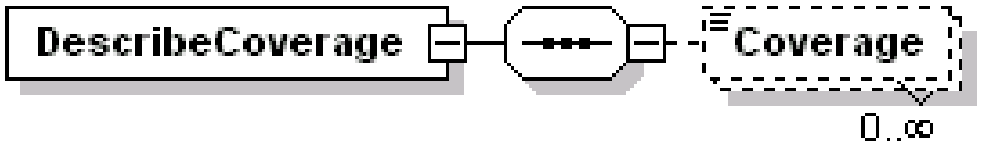
DescribeCoverage request

- Key-value pair encoding

URL Component	Description
http://server_address/path/script?	URL of WCS server. *Required.*
REQUEST=DescribeCoverage	Request name. Must be "DescribeCoverage ". *Required.*
SERVICE=WCS	Service name. Must be "WCS". *Required.*
VERSION=1.0.0	Request protocol version. *Required.*
COVERAGE=name1, name2, …	A comma-separated list of coverages to describe (identified by their name values in the Capabilities response). *Optional.* Default is all coverages, if the server supports it.

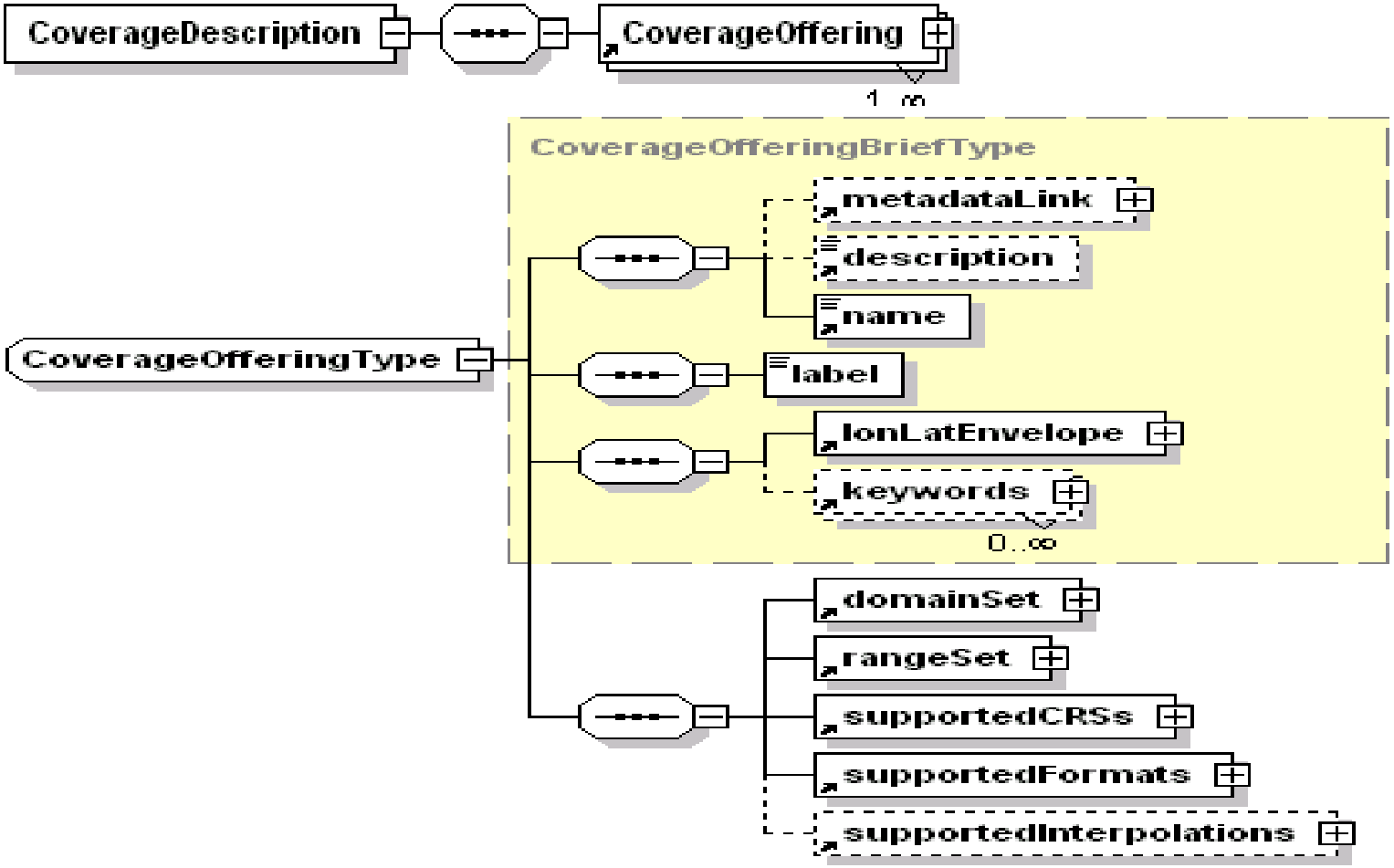
- XML encoding

```
<DescribeCoverage service="WCS" version="1.0.0">
   <Coverage>Landsat_TM_Mosaic</Coverage>
   <Coverage>WMO_Daily_Temps</Coverage>
   <Coverage>Census_population_tables</Coverage>
</DescribeCoverage>
```



- two required attributes: **service** and **version**

DescribeCoverage response



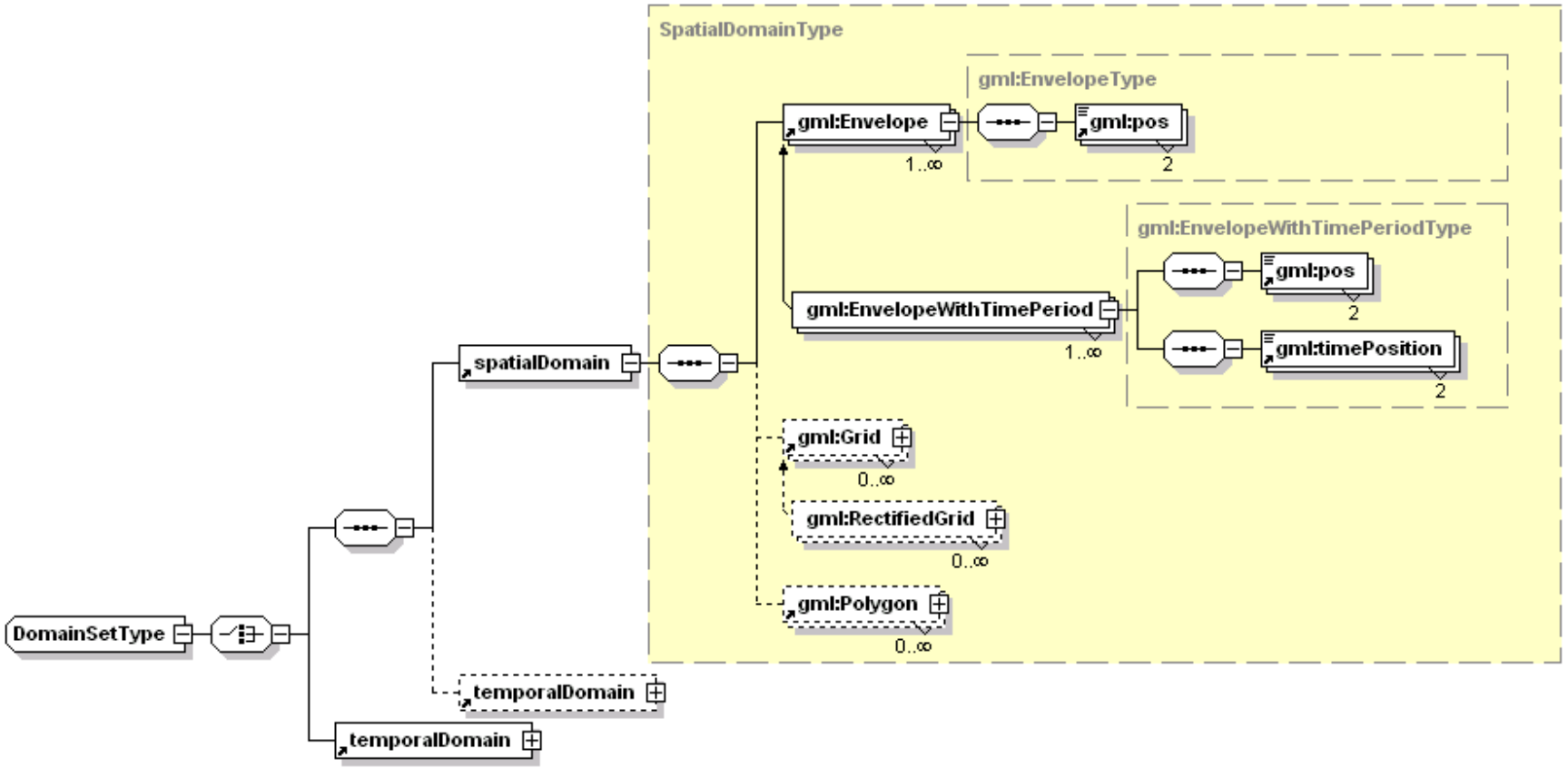
DescribeCoverage response (cont'd)

- CoverageOffering: additional elements beyond CoverageOfferingBrief

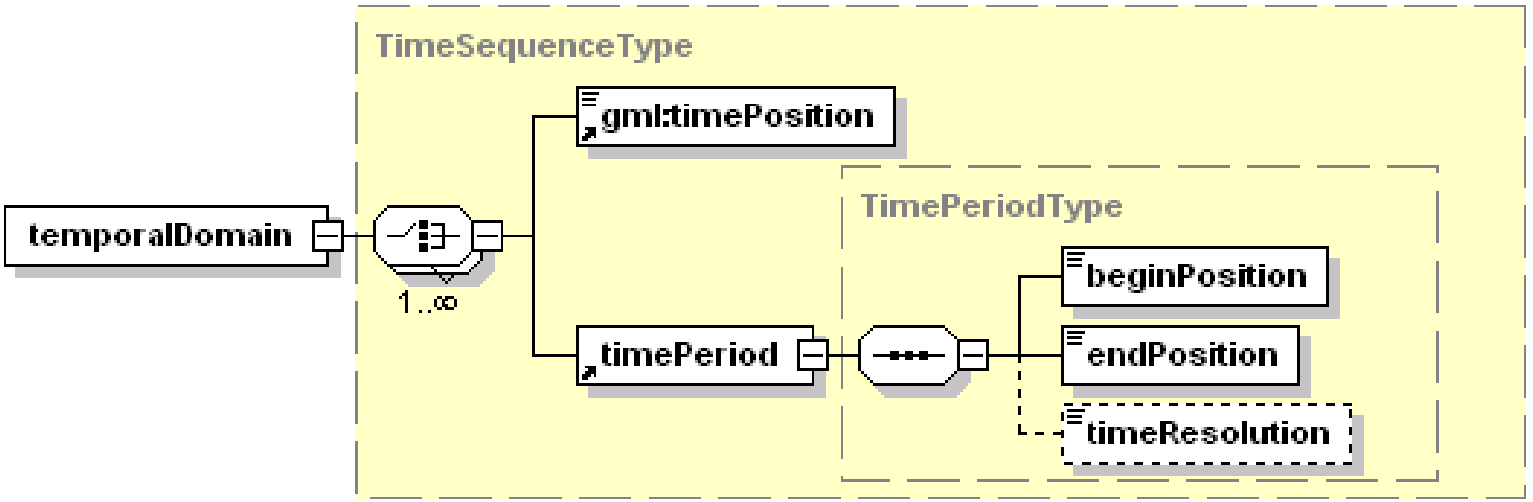
Element name	Required / Optional	Description
domainSet	Required	The available coverage locations in space and/or time available from a coverage offering
rangeSet	Required	A description of coverage values available from a coverage offering
supportedCRSs	Required	The coordinate reference system(s) in which the server can accept requests against this coverage offering and produce coverages from it.
supported-Formats	Required	The formats (file encodings) in which the server can produce coverages from this coverage offering.
supported-Interpolations	Optional	The spatial interpolation methods available for resampling or generalizing coverage values when needed to fill a GetCoverage request.

DescribeCoverage response (cont'd)

- domainSet / SpatialDomain

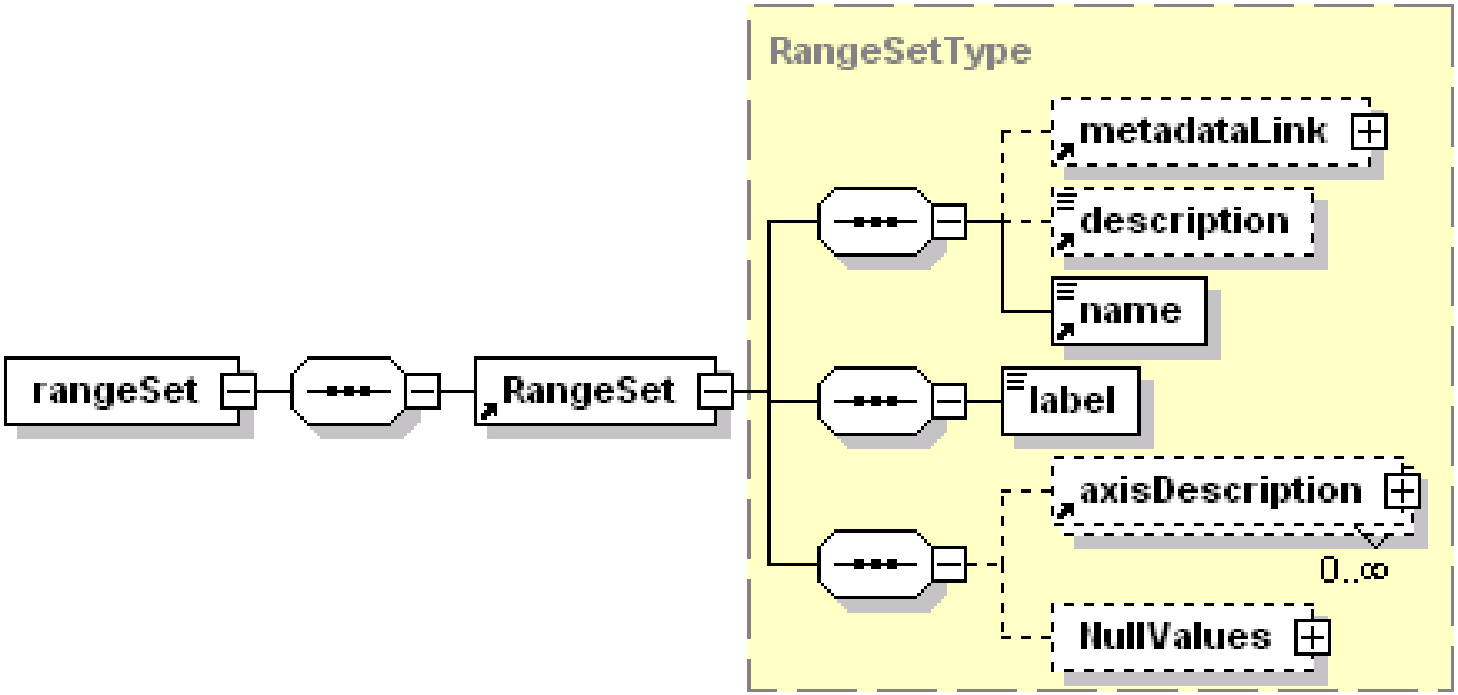


- domainSet / TemporalDomain

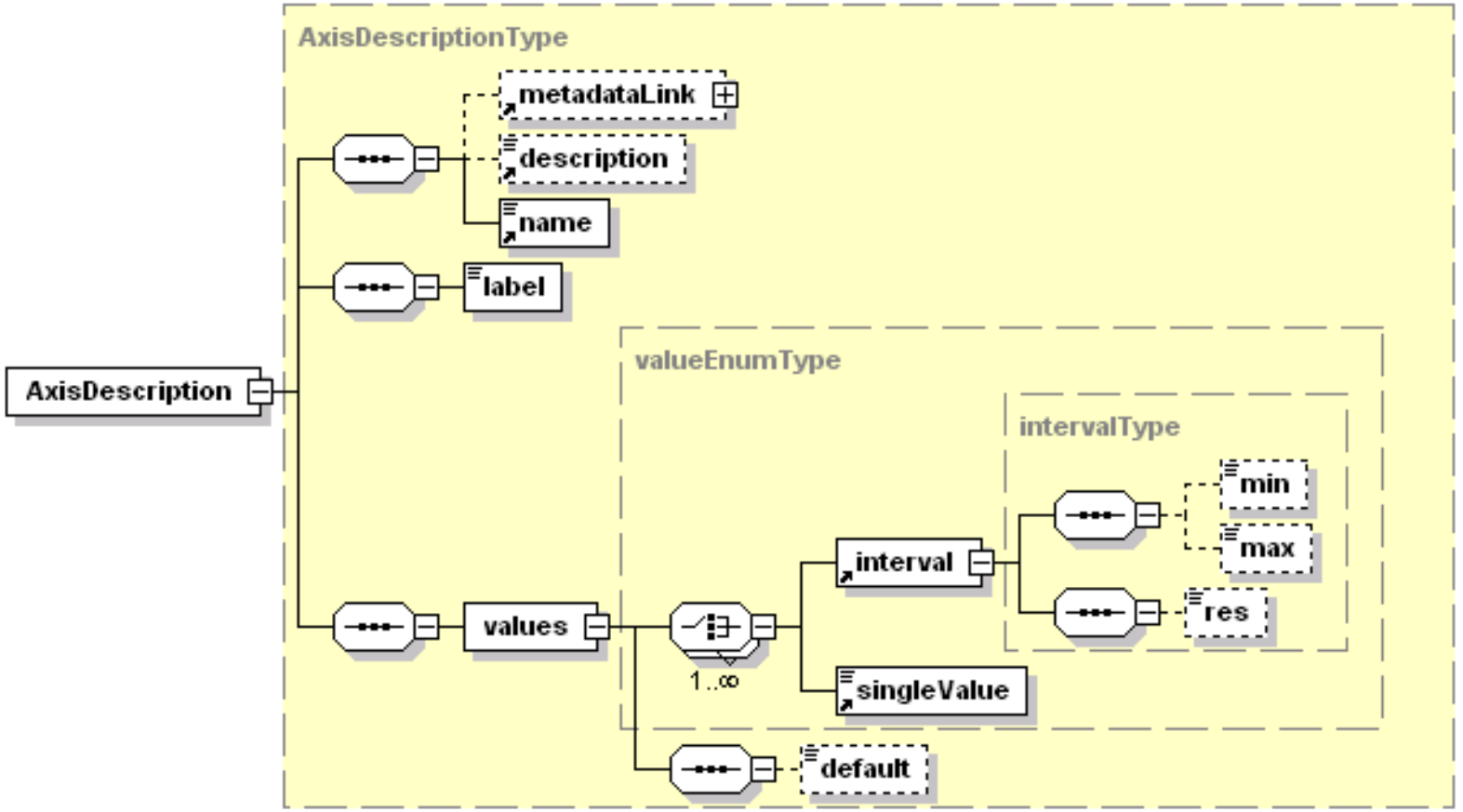


DescribeCoverage response (cont'd)

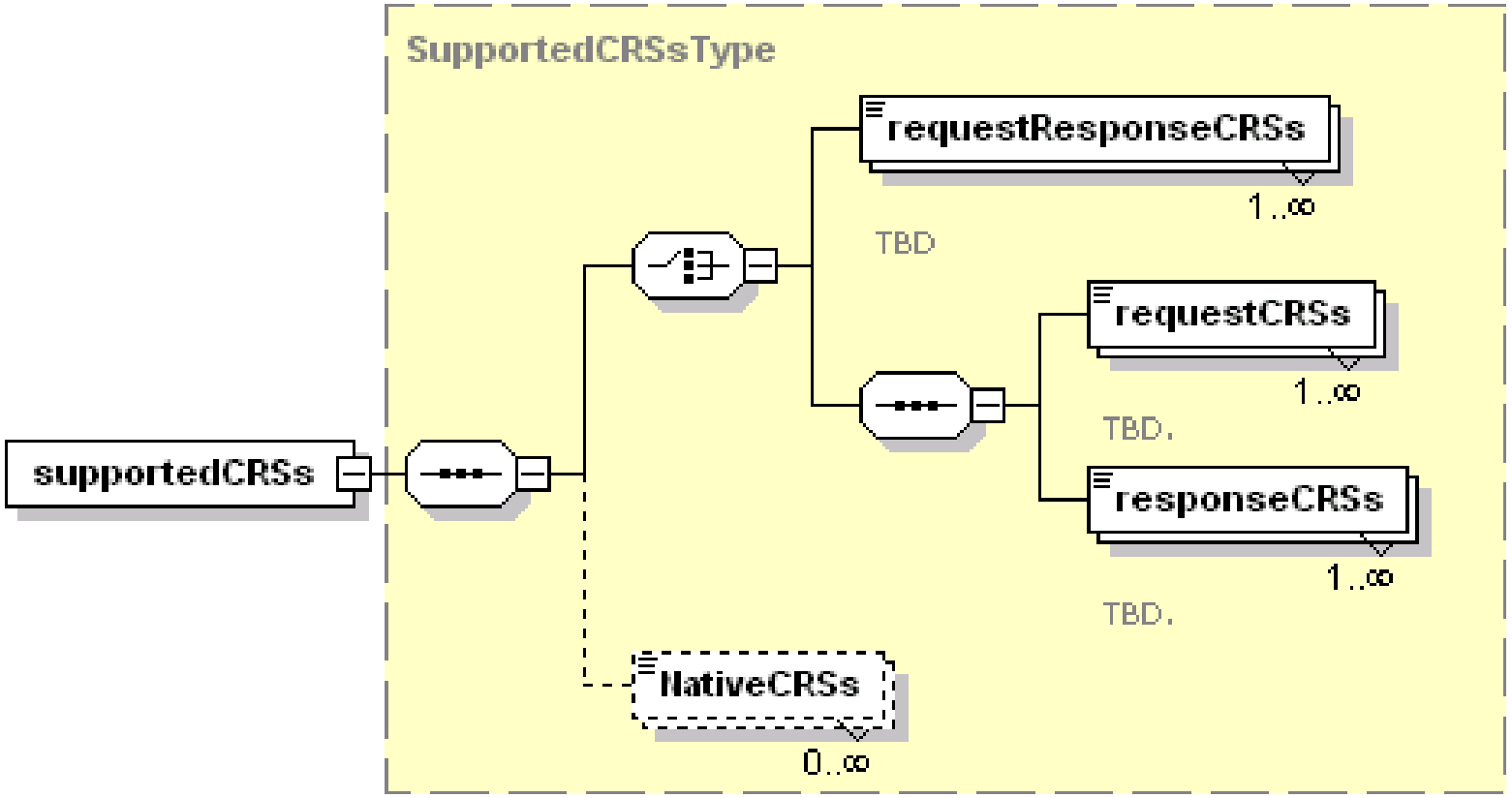
- rangeSet



- AxisDescription



- SupportedCRSs



DescribeCoverage response (cont'd)

- SupportedFormats (a simple string): GeoTIFF, HDF-EOS, DTED, NITF, GML (one of the formats has to be supported).
- SupportedInterpolations

Interpolation Method	Description
nearest neighbor (default)	These are defined in ISO 19123 (Schema for Coverage Geometry and Functions), Annex B.
bilinear	
bicubic	
lost area	
barycentric	
none	No interpolation is available; requests must be for locations that are among the original domain locations.

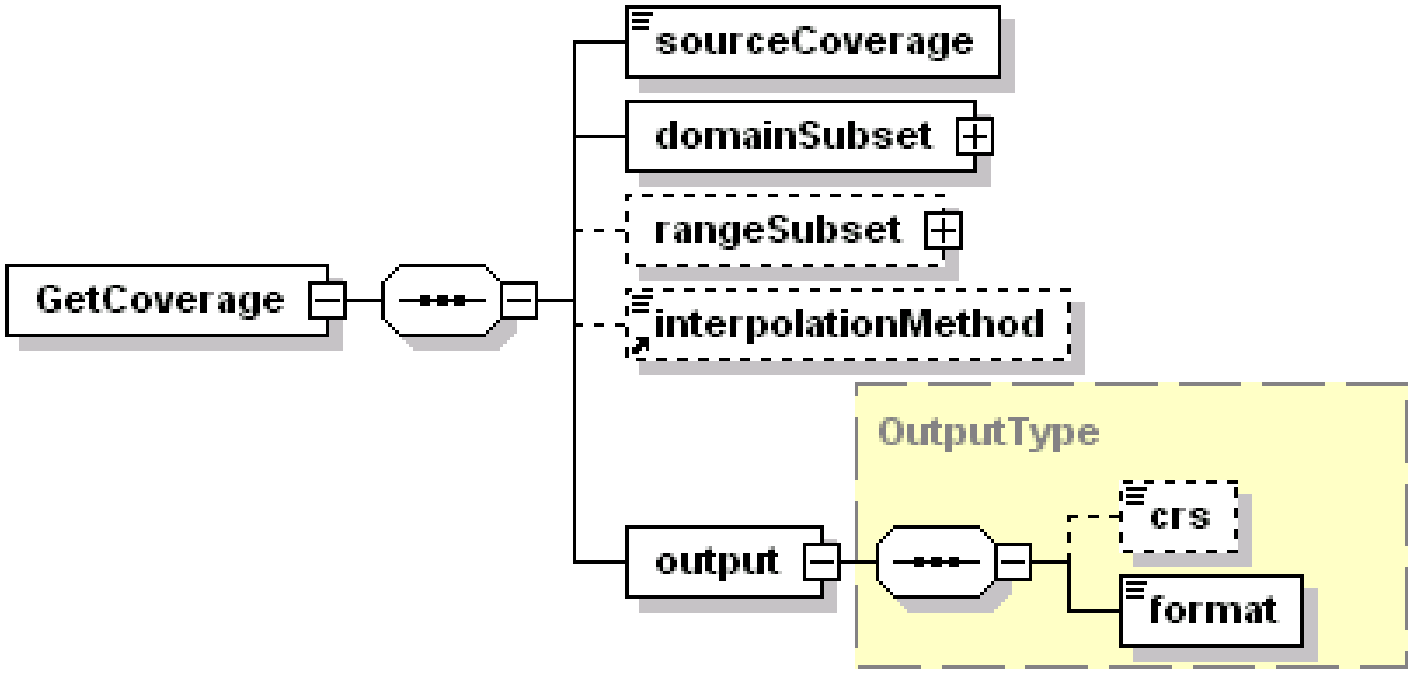
GetCoverage request

- Key-value pair encoding

- http://server_address/path/script?
- SERVICE=WCS
- VERSION=1.0.0
- REQUEST=GetCoverage
- COVERAGE=*name*
- CRS=crs_identifier
- RESPONSE_CRS= crs_identifier
- BBOX=minx, miny, maxx, maxy, minz, maxz
- TIME= *time1,time2,…* *or* TIME= *min/max/res, …*
- *PARAMETER*= *val1,val2, …* *or* *PARAMETER*= *min/max/res*
- WIDTH = w *(integer)*
- HEIGHT = h *(integer)*
- [DEPTH =d *(integer)*]
- RESX=*x (double)*
- RESY=*y (double)*
- [RESZ=*z (double)*]
- FORMAT= *format*
- EXCEPTIONS= application / vnd.ogc.se_xml

GetCoverage request (cont'd)

- XML encoding



GetCoverage response

- The server has to make the coverage that meets exactly the requirements encoded in the GetCoverage request.
- The returned coverage should be encoded in format specified in the GetCoverage request.
  - The format should be one of the formats listed in **supportedFormats** for the requested coverage offering.
- Or Exception in case of invalid request.

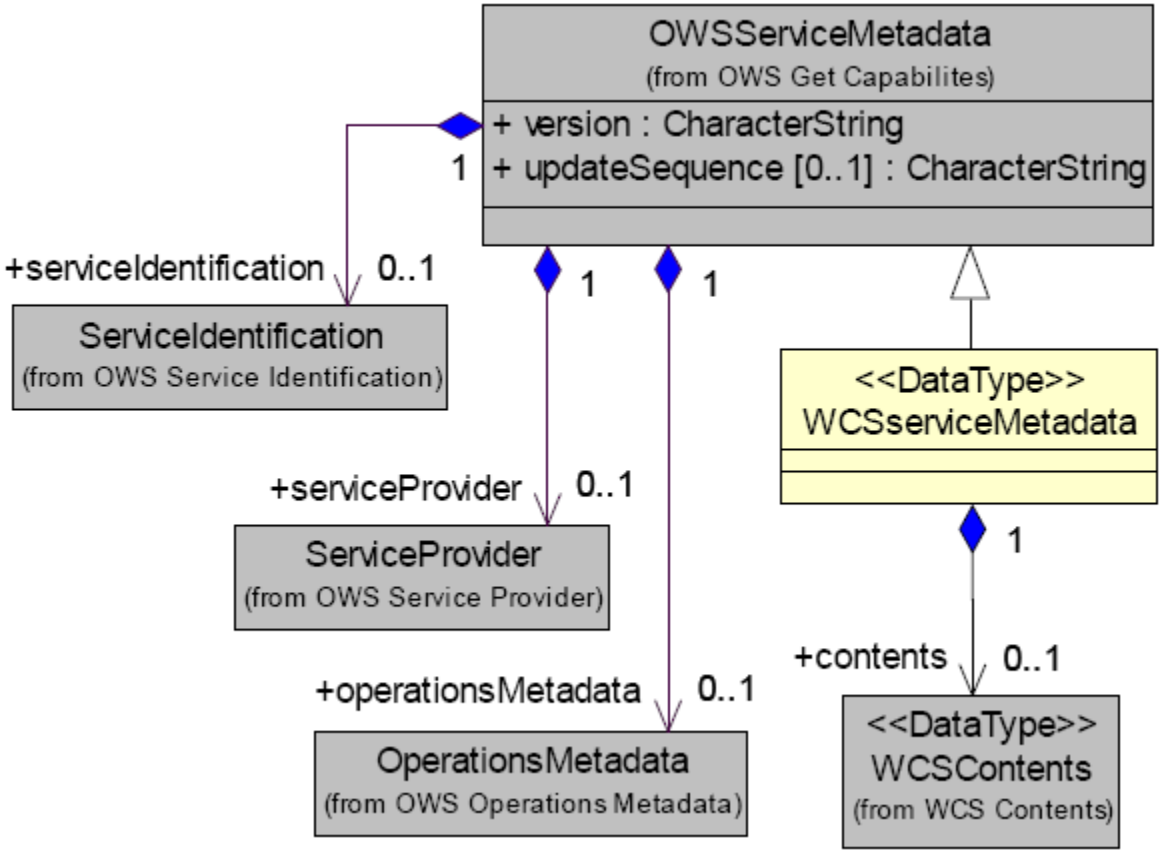
WCS version 1.1

- WCS Version 1.1 is the latest version of stable OGC WCS Specification.
- Originally the latest version number was 1.1.0, which was almost a complete rewrite of WCS 1.0.0, with many editorial changes and detailed streamlining of schema files resulting from OWS Common conformance.
- Two corrigenda were made to version 1.1.0.
- Corrigendum 1 fixed minor inconsistencies, spelling mistakes, and added some minor clarifications; and aligned with OWS-Common version 1.1.0
- Corrigendum 2 further fixed minor inconsistencies, spelling mistakes, and adds some minor clarifications.
- Thus, some people may refer the latest WCS specification to as WCS1.1.2 while other may use 1.1.0 (or 1.1.1 or WCS1.1).
- The next slide highlights the new functions in WCS 1.1.0.

WCS version 1.1.0

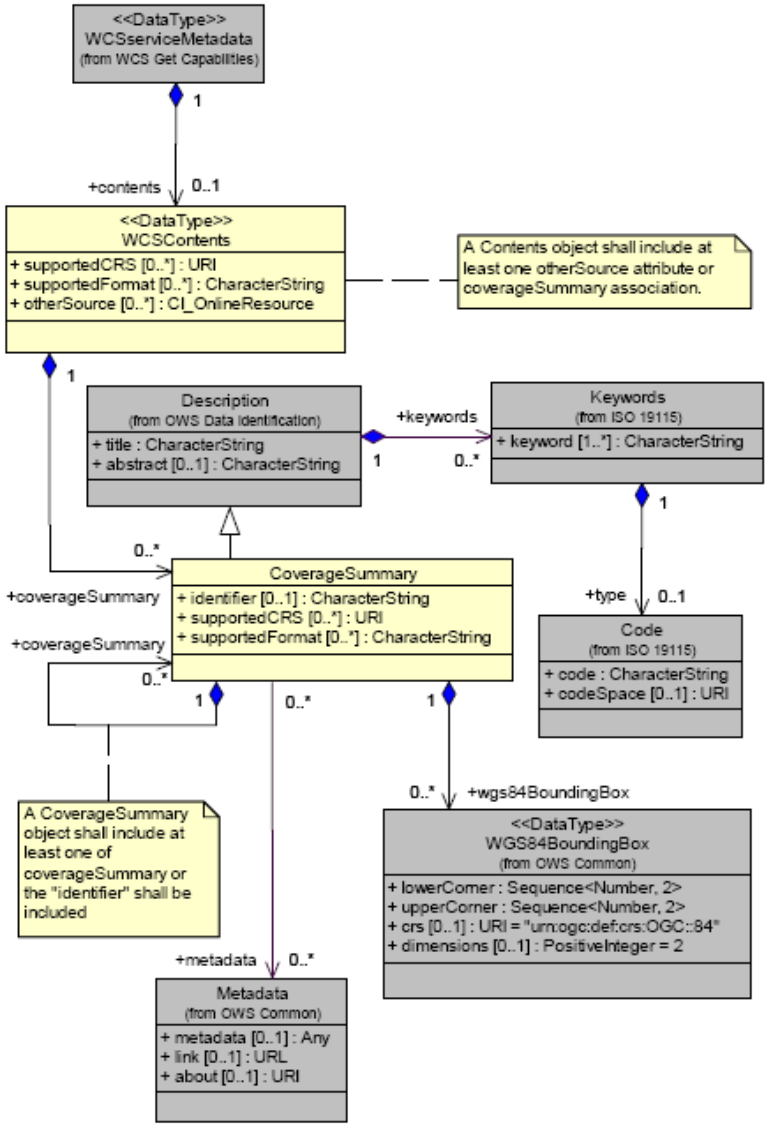
- Additional functions introduced in WCS 1.1.0:
  - Use of GridCRS in coverage descriptions and requests
    - For defining detailed grid information such as origin, offset, and base CRS of the grid.
  - Hierarchical coverage descriptions
    - Allowing common metadata descriptions be inherited/shared.
  - Multiple fields per coverage
    - A very important new feature.
    - Allowing more than one fields (variables) be requested with one getCoverage request.
  - XML and (optionally) asynchronous GetCoverage responses, not one coverage file.
  - Different approach to coverage formats
    - Using encoding profiles, not relying on preferred formats.

Service Metadata



WCS version 1.1.0

Content Metadata

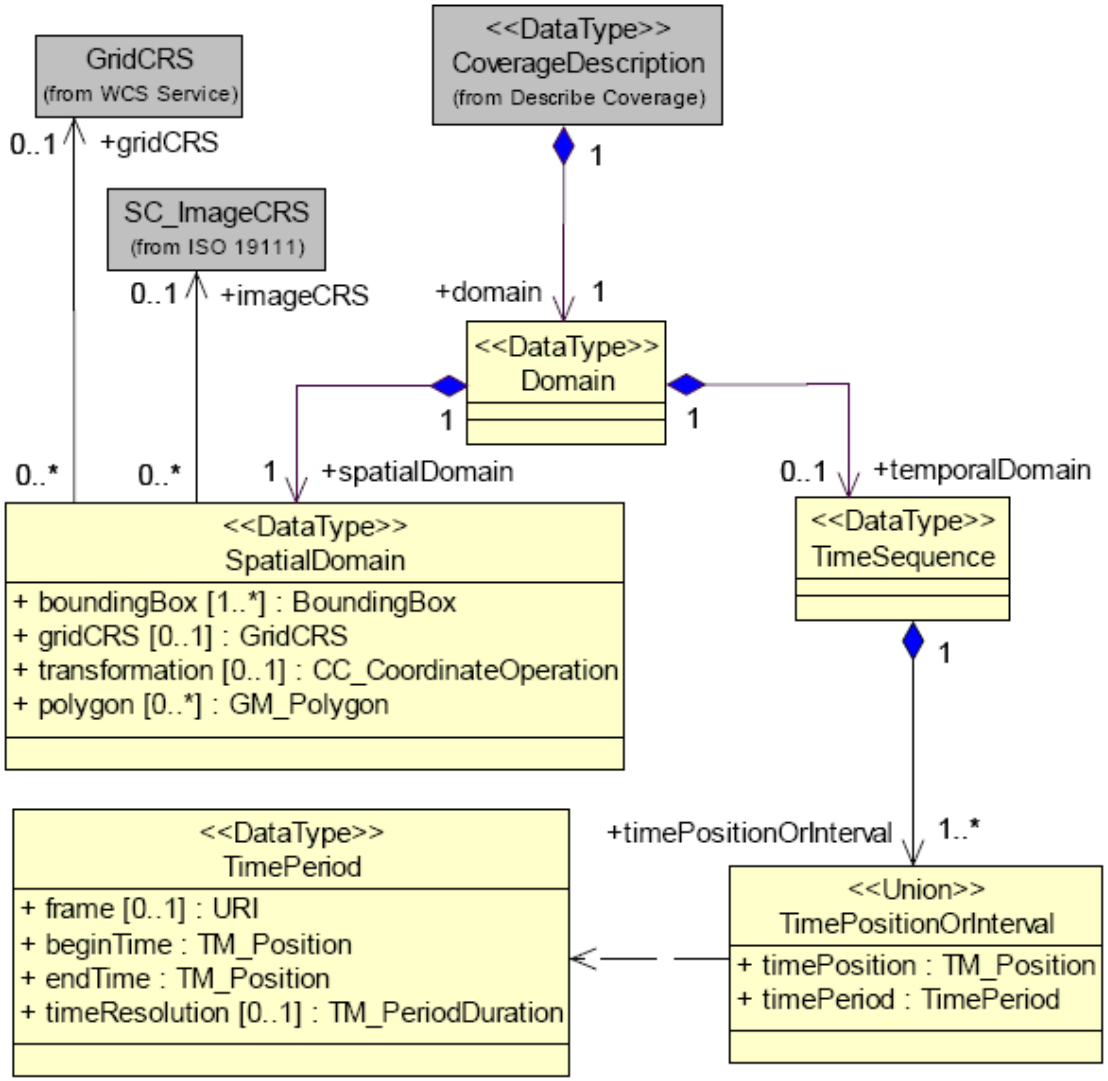


Inheritance of Coverage Summary

Name	Definition	Inheritance by subsidiary coverages
Description	Description of a coverage	Not inherited [a, b]
Identifier	Unambiguous identifier of this coverage, unique for this WCS server	Not inherited [a, c]
Metadata	Reference to more metadata about this coverage	Not inherited [a, c]
WGS84-BoundingBox	Minimum bounding rectangle surrounding coverage, using WGS 84 CRS with decimal degrees and longitude before latitude	Inherited when not provided [d, e]
SupportedCRS	CRS in which GetCoverage operation response may be expressed	Inherited and possibly added to [f, h]
Supported Format	Format in which GetCoverage operation response may be encoded	Inherited and possibly added to [g, h]
Coverage Summary	Metadata describing one subsidiary coverage available from this server	Not inherited

WCS version 1.1.0

Domain UML



Domain Data Structure

Names [a]	Definition	Data type	Multiplicity and use
boundingBox BoundingBox	Unordered list of bounding boxes whose union covers spatial domain of this coverage [b]	BoundingBox data structure, see Subclause 10.2 in [OGC 05-008]	One or more (mandatory) Include for each bounding box useful for recording spatial domain
gridCRS GridCRS	Definition of GridCRS of this coverage	GridCRS data structure, see Annex G	Zero or one (optional) Include when coverage is georectified and thus has GridCRS
transformation Transformation	Georeferencing coordinate transformation for unrectified coverage	CC_CoordinateOperation, see ISO 19111 [c]	Zero or one (optional) Include when available [d]
imageCRS imageCRS	Association to ImageCRS of this coverage	Association to ImageCRS	Zero or one (optional) Include when coverage is an image
polygon Polygon	Unordered list of polygons whose union covers spatial domain of this coverage [e]	GM_Polygon, see ISO 19107	Zero or more (optional) Include one for each polygon needed

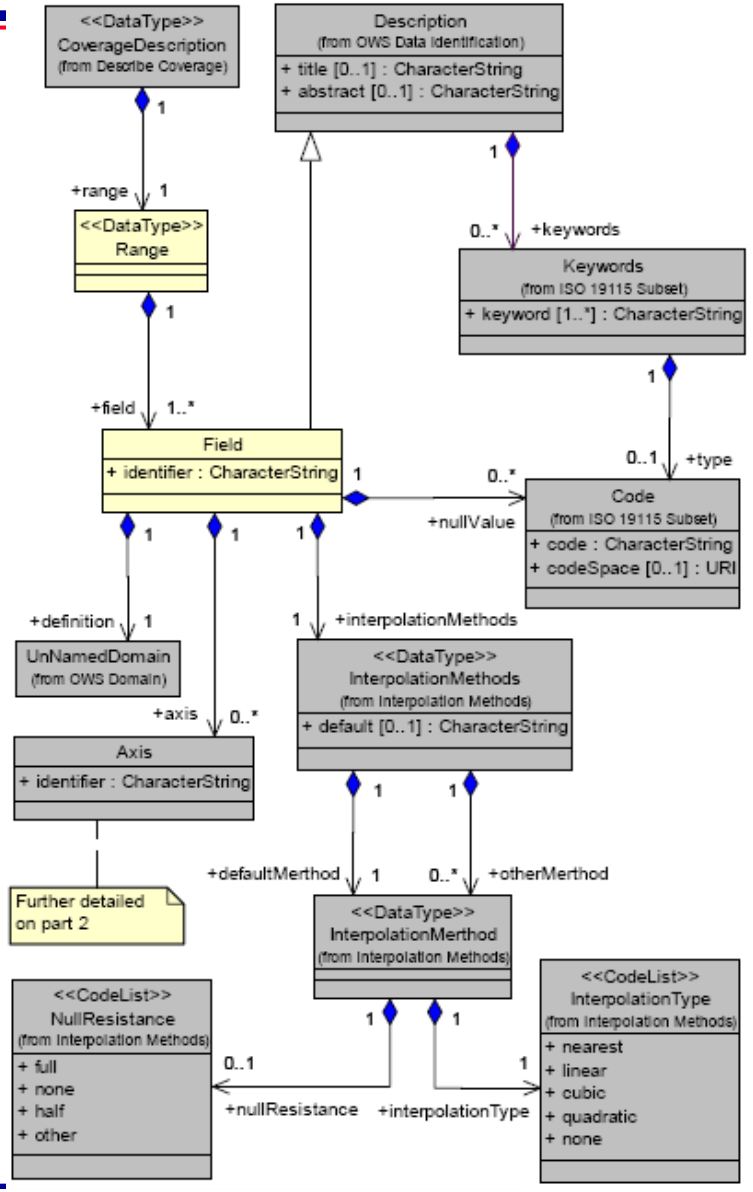
WCS version 1.1.0

Grid Data Structure

Names [a]	Definition	Data type and value	Multiplicity and use
srsName srsName	Name or identifier of this GridCRS	Character string type, not empty	Zero or one (optional) Include when needed so this GridCRS can be referenced
gridBaseCRS GridBaseCRS	Reference to definition of base CRS used by this GridCRS	URI [b]	One (mandatory)
gridType GridType	Reference to definition of operation method that specifies quadrilateral grid in GridBaseCRS	URI Default is "**urn:ogc:def:method:WCS:1.1:2dSimpleGrid**"	Zero or one (optional) Include when not default GridType
gridOrigin GridOrigin	Position coordinates of origin of this GridCRS in the GridBaseCRS	Sequence<Double> Default is "**0.0 0.0**"	Zero or one (optional) Include when not default origin
gridOffsets GridOffsets	Position offsets between adjacent points in rectangular grid, in each dimension of GridCS in each dimension of GridBaseCRS	Sequence<Double>	One (mandatory)
gridCS GridCS	Reference to definition of 2D or 3D CartesianCS used by this GridCRS	URI Default is "**urn:ogc:def:cs:OGC:0.0:Grid2dSquareCS**"	Zero or one (optional) Include when not default GridCS

WCS version 1.1.0

Range UML



Field Data Structure

Names [a]	Definition	Data type	Multiplicity and use
(Description) [b]	Description of this field	Description data structure, see [OGC 05-008]	One (mandatory) [b]
identifier Identifier	Identifier of this field, unique for this coverage	Character string type, not empty	One (mandatory)
definition Definition	Further definition of this field, including meaning, units, etc.	UnNamedDomain data structure, see Annex E [e]	One (mandatory)
nullValue NullValue	Value used when valid range values are not available [c]	Code data structure, see [OGC 05-008]	Zero or more (optional) Include when needed [c]
interpolationMethods InterpolationMethods	Spatial interpolation method(s) that server can apply to this field [d]	InterpolationMethods data structure, see Subclause I.4	One (mandatory)
axis Axis	Axis ("control variable") of vector field for which there are range values	Axis data structure, see Table 20	Zero or one (optional) Include for each axis of a vector field (i.e., one that has axes)

Axis Data Structure

Names [a]	Definition	Data type	Multiplicity and use
(Description) [b]	Description of this field	Description data structure, see [OGC 05-008]	One (mandatory) [b]
Identifier identifier	Identifier of this axis, unique for this field	Character string type, not empty	One (mandatory)
availableKeys AvailableKeys	List of values of keys for this axis	AvailableKeys data structure, see Table 21	One (mandatory)
meaning Meaning	Reference to meaning or semantics of this value or set of values	DomainMetadata data structure, see Table E.7	Zero or one (optional) Include when useful
dataType DataType	Reference to the data type of this set of values	DomainMetadata data structure, see Table E.7	Zero or one (optional) Include when useful
valuesUnit ValuesUnit	Indicates that this quantity has units or reference system, and provides the value used [c]	ValuesUnit data structure, see Table E.4	Zero or one (optional) Include when values have units or reference system
metadata Metadata	Additional metadata about domain of this quantity	ows:Metadata, see Table 23 of OGC 05-008	Zero or more (optional) One for each such metadata object [d]

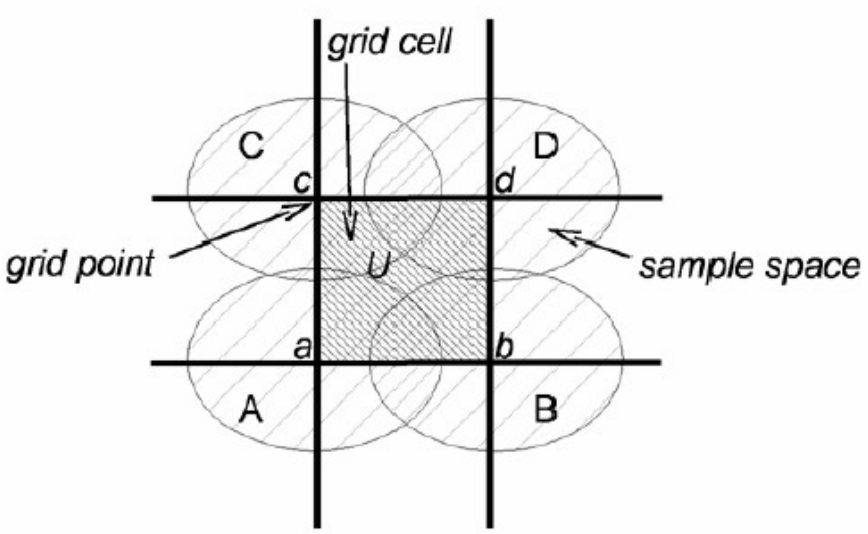
WCS version 1.1.0

KVP Encoding

identifier=identifier	Mandatory	Unique identifier of an available coverage
BoundingBox=47,-71, - 51,66, urn:ogc:def:crs:EPSG:6.6:6326 6405	Optional, include when spatial subset desired [b]	Request a coverage subset defined by the specified bounding box in the referenced coordinate reference system
TimeSequence= 20060801, 20060811, … OR TimeSequence = 20060801/ 2006-0901 / P1D, …	Optional, include when temporal subset desired other than default [b]	Request a subset corresponding to the specified time instants or intervals, expressed in the extended ISO 8601 syntax defined in Annex D of [OGC 04-024]. (See 9.3.2.4.)
RangeSubset=temp:nearest; radiance[band[1,2,5]] *(see syntax below)*	Optional; include when requesting values for only some of the available fields or field keys; or non-default interpolation types on fields.	Request only some fields OR subsets of some fields (OR list fields to request non-default interpolation on them). *(see syntax below)*
format=image/netcdf	Mandatory	Requested output format of Coverage. Shall be one of those listed in the description of the selected coverage
store=true	Optional, include when supported and not false	Specifies whether response coverage should be stored, remotely from client at network URL, a boolean value
GridBaseCRS=urn:ogc:def:crs:EP SG:6.6:32618	Optional, include all of five GridCRS parameters, except for defaulted parameters, to request output in a CRS other than the ImageCRS of stored coverage	Reference to baseCRS of desired output GridCRS, a URN [c]
GridType=urn:ogc:def:method:W CS:1.1:2dGridIn2dCrs		Reference to grid type of desired output GridCRS, a URN [c, d]
GridCS=urn:ogc:def:cs:OGC:0.0: Grid2dSquareCS		Reference to coordinate system of desired output GridCRS, a URN [c, e]
GridOrigin=0,0		Position coordinates of one possible grid origin, in baseCRS of desired output GridCRS [c, f]
GridOffsets=0.0707, -0.0707,0.1414,0.1414&		Offsets between adjacent grid points, in baseCRS of desired output GridCRS [c, g]

WCS version 1.1.0

- WCS1.0.0 does not explicitly specify the difference between grid point and grid cell. Sometimes people use different ways in defining a grid's boundary.
- WCS1.1.0 clarifies this point by explicitly referring to ISO 19123.
- Grid points, grid cells, and sample spaces are shown as the following:



Support SOAP Encoding

- SOAP (Simple Object Access Protocol): exchanging XML-based messages over networks, normally using HTTP/HTTPS.
- SOAP provides a basic messaging framework upon which abstract layers can be built.
- SOAP envelope, header, body.

```
<SOAP:Envelope>
        <SOAP:Header>
        </SOAP:Header>
        <SOAP:Body>
        </SOAP:Body>
</SOAP:Envelope>
```

SOAP with attachment: support getCoverage response.

```
MIME-Version: 1.0
Content-Type: Multipart/Related; boundary=MIME_boundary; type=text/xml;
                start="<claim061400a.xml@claiming-it.com>"
Content-Description: This is the optional message description.

--MIME_boundary
Content-Type: text/xml; charset=UTF-8
Content-Transfer-Encoding: 8bit
Content-ID: <claim061400a.xml@claiming-it.com>

<?xml version='1.0' ?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
<SOAP-ENV:Body>
..
<theSignedForm href="cid:claim061400a.tiff@claiming-it.com"/>
..
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>

--MIME_boundary
Content-Type: image/tiff Content-Transfer-Encoding: binary
Content-ID: <claim061400a.tiff@claiming-it.com>

...binary TIFF image...
--MIME_boundary--
```

Revisions and Related Specifications

- The WCS revision working group is working on revising WCS.
- Newer version will be WCS 1.2 (on-going)
- Defining requirements for WCS Base and Extensions
- WCS - Processing Extension
- WCS – Transaction Operation Extension
- JPEG2000/JPIP/netCDF/HDF coverage encoding profiles
- Non-grid Coverages (use case from the GALEON project)

GMU WCS Implementation

- WCS 1.0 and 1.1 have been implemented by GMU to support distribution of HDF-EOS data to users.
  - Both HDF4-EOS and HDF5-EOS are supported.
  - WCS transaction
  - Support GeoTIFF data and simple binary
  - On-the-flying georectification
  - On-the-flying reprojection (Supporting all projections in USGS map projection software)
  - Output coverage to over 30 formats, including netCDF, HDF-EOS, and others.
- Our experience indicated that it is not an easy task to support all HDF-EOS products because
  - Diverse in HDF-EOS
  - Product not following the HDF-EOS standards.
  - We have to test and customize for individual products.